



REVISION OF THE FAMILY *EUSTHENIIDAE* (ORDER PERLARIA)
WITH DESCRIPTIONS OF NEW GENERA AND SPECIES.

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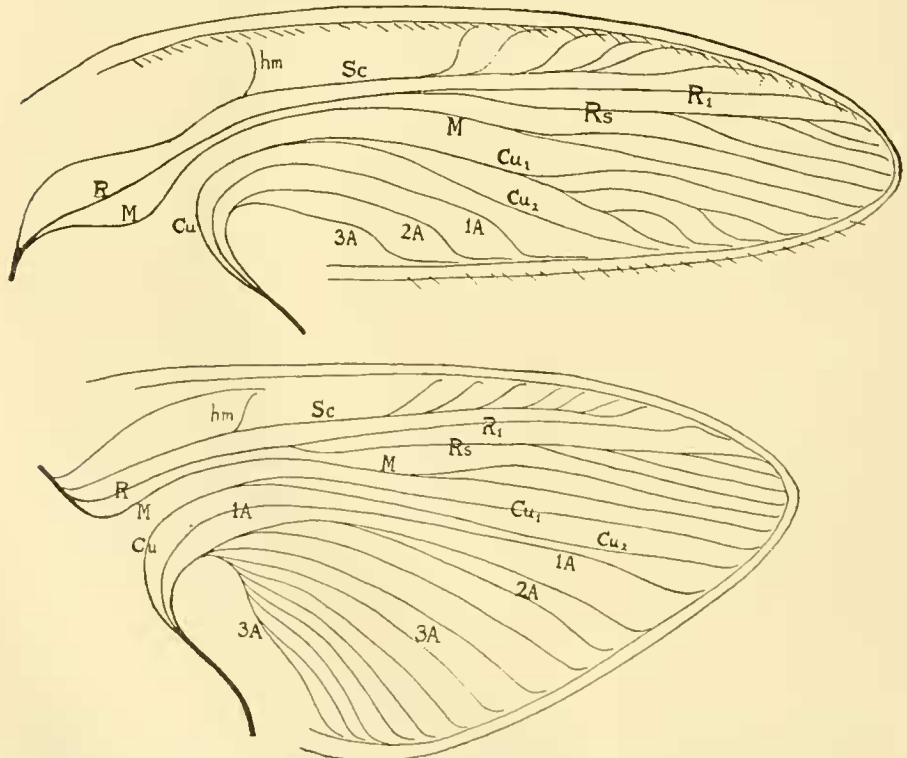
(Plates xi.—xv., and four Text-figures.)

In a paper published recently in the *Canadian Entomologist* (Feb., 1921, pp. 35—44), I have given a revision of the classification of the Order Perlaria, or Stone-flies, based on a study of the world fauna, with special reference to the archaic groups found in the Southern Hemisphere. In that revision, the *Eustheniidae* are, for the first time, definitely recognised as a distinct family, and their characters clearly defined. These large and, for the most part, very beautifully coloured Stone-flies are shown to possess only archaic family characters; in other words, though existing to-day, they represent the original archetypic family of the Order, from which all other types must have been derived. Their principal characters, all of which will be readily recognised as archaic, are the following:—the presence of five or six pairs of lateral abdominal gills in the larva; the close correspondence between the wing-tracheation of the larva and the wing-venation of the imago; the strongly formed imaginal mandibles; the normal structure of the clypeus and labrum; in the imaginal wing-venation, the absence of the transverse cord or anastomosis; the presence of cross-veins in all parts of the wing, including the anal fan; the forewing with three anal veins; the anal fan of the hindwing very large, and its margin forming a single continuous curve with that of the rest of the wing above the vena *dividens* (Cu_2). This last character serves to distinguish the *Eustheniidae* at sight from all other Perlaria.

At the present time, only four species appear to have been described which properly belong to this family. These are *Eusthenia spectabilis* Westwood (1832) from Tasmania, *E. costalis* Banks (1913) also from Tasmania, *Stenoperla prasina* (Newman), (1845), from New Zealand, and *Diamphipnoa annulata* (Br.), (1869), (= *D. lichenalis* Gerst., 1873) from Southern Chili. *Eusthenia thalia* Newm. (1839) from Tasmania, is not a true Eustheniid at all, but belongs to the family *Austroperlidae*. In my previous paper, already cited, I have proposed a new genus *Tasmanoperla* for the reception of this and the closely allied species *T. diversipes* Till.

During my visit to England, from June to August of last year, I studied the material belonging to this family in the British Museum, and also in the Hope Museum at Oxford. There is, fortunately, in the latter Museum, a very fine specimen of *Diamphipnoa annulata*, of which, through the kindness of Professor Poulton, I have received an excellent photograph. This is reproduced, enlarged, in Plate xiv., fig. 8. It will be readily seen that it is a true Eustheniid in every respect, thus justifying Banks' grouping of it with *Stenoperla* in his tribe Eustheniini, as opposed to Enderlein's placing of it in the family *Pteronarcidae*.

While in Melbourne in April, 1920, I went through the collections of the National Museum, and discovered there a magnificent new Stonefly, quite unlike anything hitherto known. It had been taken at Warburton, on the Upper Yarra River, many years previously (there is no date on the label), and had remained unnoticed for many years. The Curator kindly loaned me it for study, and I have been able to show it to many entomologists in England and America. This remarkable insect belongs to the family *Eustheniidae*, within which it will be placed, in this paper, as the sole representative of a new genus *Thaumtoperla*, forming the only known member of a new subfamily *Thaumtoperlinae*. It is figured in Plate xi., fig. 1.



Text-fig. 1—*Stenoperla prasina* (Newman). Tracheation of wings of last larval instar. 1A, 2A, 3A, the three anal tracheae; Cu, cubitus; Cu₁, Cu₂, its two main branches; hm, humeral veinlet; M, media; R, radius; R₁, its anterior branch; Rs, its posterior branch, or radial sector; Sc, subcosta. (x 36).

The genus *Stenoperla* is already well known to me through a prolonged study of it during my visit to New Zealand in 1919-20. While staying with Professor Chilton at the Cass Biological Station in January, 1920, I took the opportunity to collect the larvae of the only known species, *S. prasina*, and to dissect off their wing-sheaths. The very beautiful wing-tracheation of this insect is shown in Text-fig. 1. Apart from a certain amount of fusion of the main veins at their bases, which is characteristic of the order as a whole, it will be seen that the courses of the tracheae are exactly those of the subsequently formed veins. This character indicates that no striking tracheational or venational specialisations occur in this family. The imago of *S. prasina* is shown in Plate xv., fig. 9.

Larvae of an unknown species of *Stenoperla* have long been known to me as occurring quite commonly in the fast mountain streams of the Blue Mountains and South Coast districts of New South Wales. In 1912, Dr. A. J. Turner, of Brisbane, captured a fine new *Stenoperla* at Montville, Blackall Ranges, Queensland, and sent it to me. In 1915 I visited Maleny, not far from Montville, and found a large *Stenoperla* larva fairly common there; from it I succeeded in breeding out Dr. Turner's species. Later, I both bred and captured the same species at Stanwell Park, N.S.W., and have received it from Victoria also. This species is described in the present paper, under the name *S. australis*, n.sp. (Plate xv., fig. 10).

The close relationship existing between the genera *Stenoperla* and *Diamphipnoa* is so evident that I propose, in this paper, to associate them together in a new subfamily, *Stenoperlinae*.

The genus *Eusthenia* holds an intermediate position, morphologically, between the excessively broad, clumsily-built *Thaumtoperlinae* and the slender and graceful *Stenoperlinae*. A number of new species are described in this paper. One of these, from Victoria, differs considerably from the rest in the shape of its wings and in an important venational character. I have, therefore, proposed a new genus *Eustheniopsis* for its reception. This same new genus will also include the species labelled "*Eusthenia reticulata* Klap." in the British Museum Collection.

The zoo-geographical distribution of the family is of considerable interest. *Eusthenia* is confined to Tasmania; *Eustheniopsis*, n.g., occurs in both Tasmania and Victoria; *Thaumtoperla* is only known from Victoria; *Stenoperla* occurs throughout New Zealand and the mountains of Eastern Australia, but is absent from Tasmania; and, finally, *Diamphipnoa* is found only in Southern Chili. Thus the family may be said to have had either a Notogaean or even perhaps an Antarctic origin. As the *Eustheniidae* represent the archetypic family of the Order Perlaria, the same would appear to be true of the Order. If this be granted, the present distribution of the Perlaria is easily understood. For, as the Stone-flies spread northwards through Central America to Holarctica, the three oldest families, *Eustheniidae*, *Austroperlidae* and *Leptoperlidae*, were left behind, so that nothing but comparatively specialised forms is to be found in the Northern Hemisphere.

The distribution of the family certainly presents a strong argument in favour of the Antarctic Theory. For the *Stenoperlinae* are represented in Australia, New Zealand and Chili, and nowhere else in the world. Such a distribution is scarcely to be explained on any other hypothesis.

All three subfamilies are represented in the ranges of Southern Victoria, which may therefore be regarded as the headquarters of the family.

Family EUSTHENIIDAE.

Key to the Subfamilies.

1. Wings very short and broad, the forewing less than twice as long as broad; M_5 in forewing very strongly formed, making an acute angle with M_{1-4} distally. Costa of forewing strongly dilated basally. Branches of Rs arising from R as a pectinate series of apparently separate sectors.

THAUMATOPERLINAЕ, n.subfam

Wings not exceptionally short and broad, the forewing always more than twice as long as broad. M_5 less strongly formed, making either a right angle or an obtuse angle with M_{1-4} distally. Costa of forewing not dilated basally. Branches of Rs in forewing dichotomic, arising normally from Rs 2

2. Stoutly built insects of red or purple colouration, the forewing less than thrice as long as broad. Cerci long, from 12 to 16 mm.,

EUSTHENIINAЕ, n.subfam.

Much more slenderly built insects of green, yellow, brown or grey colouration, the forewing about five times as long as broad. Cerci short, from 5 to 8 mm.

STENOPEERLINAЕ, n.subfam.

Subfamily THAUMATOPERLINAЕ, n.subfam.

Genus THAUMATOPERLA, n.g. (Plate xi., fig. 1.)

Characters as given in the key for the subfamily, with the following additions:—*Antennae* with fifty or more joints, the basal joint much enlarged. *Maxillary palpi* five-jointed, the basal joint a mere ring, the other four broad and flattened, the second being very short, the third longer, broad and femur-like, the fourth longer and narrower, the distal joint shorter and narrower still, with rounded apex. *Labial palpi* three-jointed, the basal joint very short, the second fairly long, broad and flat, the third shorter and narrower, with rounded apex. *Pronotum* more than half as wide again as long. *Legs* with the femora very broad and strongly built, the tibiae long and rather slender, the tarsi hairy, the third joint long and club-shaped, carrying strong claws and a well developed empodium. *Abdomen* about as long as forewing, broad and rather flattened; the *cerci* stoutly built, of moderate length, with at least fifteen joints.

To the venational characters given for the subfamily may be added the following:—In the *forewing*, the dilated basal portion of the costal space is free of cross-veins for a short basal space, but distally from this it carries a double row of cellules. The "apparent" sectors of the radius are three to four in number, very irregular in form and position. M is completely fused with R basally for more than one-fourth of the wing-length; immediately on leaving R, it divides into M_{1-4} , descending obliquely across the middle of the wing, parallel to the radial sectors, and into M_5 , a very stoutly formed vein running quite transversely across the wing, at right angles to $R+M$, to join Cu_1 just distad from its origin from Cu , and thus forming a very conspicuous cubito-median Y-vein, of which the upper arm is more than twice as long as the lower. Cu and 1A are fused basally for about half the distance that R and M are fused. After junctioning with M_5 , Cu_1 is a strong convex vein; it has a long distal fork. Cu_2 remains concave and lies for the most part in the cubito-anal groove, but its distal end is free from this groove, lying anterior to it. 1A, immediately after leaving Cu , is connected with 2A by a strongly formed transverse vein at right angles to it; 1A is a convex, wavy vein, with a short distal fork. 2A and 3A are both irregularly wavy, forked veins.

In the *hindwing*, the dilatation of the base of the costa is quite evident, though smaller than in the forewing. Sc is forked distally. There are three or more "apparent" sectors of R, very irregular in form and position. M is not fused with R basally, but can be seen as a very weak concave vein running below it. M₅ is strongly formed, arising from M at an angle of about 60° with M₁₋₄. Cu₁ is unbranched, diverging distally from Cu₂ so as to carry a double row of cells between them for the distal third of their lengths. Cu₂ lies in the cubito-anal furrow, except for a very short apical portion. 1A arises separately from Cu but very close under it; it gradually approaches Cu, and then fuses with it in the anal furrow for a considerable distance near the middle of the wing, finally diverging from it again. 2A is forked not far from the base, and 3A has numerous branches on the anal fan. The cubito-anal furrow divides the wing into approximately two equal halves longitudinally; the contour of the distal half of the wing, from the apex of Sc to the posterior angle of the anal fan, is very nearly semi-circular.

Genotype, *Thaumatoperla robusta*, n.sp., from Warburton, Victoria.

Apart from certain very evident specialisations in the wing-venation, this remarkable genus is perhaps the most archaic type of Stonefly at present existing, and might in many respects be regarded as a true Protorthopteron. It seems quite likely that a careful study of some of the large Protorthoptera of the Upper Carboniferous, especially those from Mazon Creek, may reveal a close affinity with this genus. Characters evidently of great antiquity in the venation are the very strong development of M₅ and the strong formation of the cubito-medial Y-vein; also the primitive condition of Cu₂, which has not yet fully aligned itself into the cubito-anal groove of the wing. The well marked but irregular cross-venation, which is equally in evidence over all parts of both wings, appears to be a true archedietyon of Palaeodictyopteros or Protorthopteros origin and a feature of great antiquity. The genus is also far more archaic than any other known Stonefly in having about one-half of the area of the hindwing occupied by the veins above the cubito-anal furrow. There is also the same marked tendency towards variation in the details of venation which is found in other archaic insects, such as the Cockroaches; and this variation is particularly noticeable in comparing the two sides of the same insect.

A high specialisation of the venation is to be seen in the remarkable formation of the branches of the radius, which compares closely with that seen, in the forewings only, in the family *Hemerobiidae* of the Order Planipennia. It would appear that the true radial sector has become completely fused with the main stem of R, so that its branches come off as separate sectors. In such a case, it is usual to call these branches "apparent" radial sectors, and to state their number. Other specialisations are the great amount of fusion of R and M basally in the forewing, the fusion of Cu with 1A basally in the same wing, and a curious formation to be seen in the left hindwing only, in which the most basal of the "apparent" radial sectors has quite lost its connection with R, and is attached to M. In the right hindwing, a strong oblique cross-vein indicates the manner in which this vein-capture has been brought about.

The characters of this genus are perhaps so distinct as to justify the formation of a separate family for its reception. I have, however, determined to keep it for the present within the *Eustheniidae*, as the genus *Eustheniopsis*, n.g., is its nearest ally, and the only genus with which it shows any real affinity.

It seems most remarkable that so wonderful an insect as this should have remained unnoticed and undescribed for so many years. Though the specimen is undated, it is evidently of considerable age. It is fortunate that the Upper Yarra at Warburton still remains comparatively untouched by the growth of Melbourne, so that there are reasonable hopes of further specimens of this fine insect being discovered, and its life history being worked out.

THAUMATOPERLA ROBUSTA, n.sp. (Plate xi, Fig. 1.).

♀. *Total length*, 29 mm., *abdomen* (dried), 17 mm., *forewing*, 22 mm., *hindwing*, 20.5 mm., *expanse*, 47 mm.

Head shiny black above, with a small yellowish spot on each side of the frontal suture, just below and inwards from the base of the antenna; a transverse narrow band of olive greenish on the labrum, and a slight touch of yellowish brown on mandibles and maxillae; genae orange brown; labium dull brownish. *Eyes* dark olive grey. *Antennae* 17 mm. long, black, composed of fifty or more joints.

Thorax: *Pronotum* rich orange, the convex anterior border somewhat darkened; length of pronotum, 4.5 mm., breadth, 7.5 mm., the latter greatest anteriorly; *prosternum*, yellowish grey. *Meso-* and *metathorax* black, with a band of pale brown between the bases of the forewings; this colour extends on to the basal dilated portion of the costal space of the forewings, and carries golden hairs on both the thorax and wings. *Legs* black, the fore femora pale brown on anterior border and part of underside; the middle and hind femora with these same parts coloured more greyish yellow. *Wings* uniformly dull blackish, except for the small patch of pale brown at base of costal space of forewings, already mentioned.

Abdomen broad, nearly cylindrical, somewhat flattened, black. *Cerci* (apparently with some distal joints missing), with 15 or more short joints, the basal ones shorter than the more distal, and all carrying cilia; colour black.

Type: Holotype ♀, Collection of the National Museum, Melbourne, Victoria.

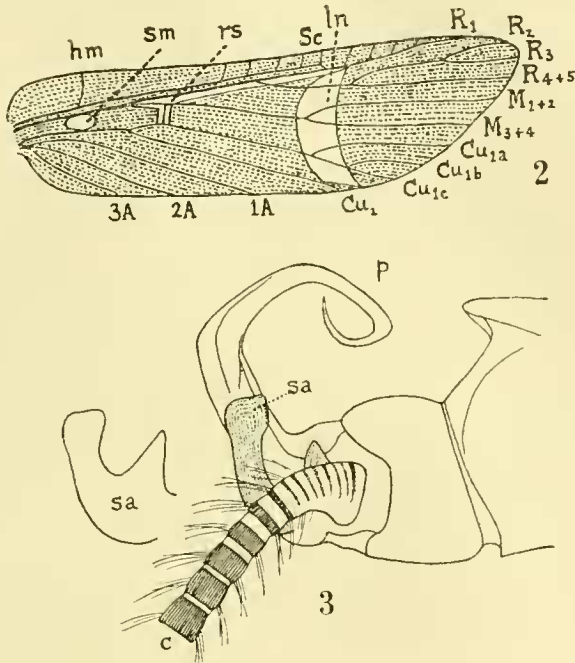
Hab.—Warburton, Victoria.

Subfamily EUSTHENIIDAE, n.subfam.

Characters as given in the Key on p. 224.

The type of markings found on the wings of the *Eustheniinae* is a great help in distinguishing the rather closely allied species. In the forewing (Text-fig. 2), attention must be paid to the following markings:—Sited transversely across the wing, at about two-thirds from the base, is the very prominent pale *lunule* (*lu*), which may be narrow or wide, and either clearly delimited both distally and basally, or somewhat indistinctly outlined basally. Along the radius, from below the humeral cross-vein (*hm*) to the apex of the lunule, there is sometimes present a red stripe, called the *radial stripe* (*rs*), which may or may not send out a short downward prolongation covering M₂, as shown in Text-fig. 2. Below the humeral cross-vein, in the basal space between R+M and Cu, there is sometimes present a pale oval mark called the *subhumeral oval mark* (*sm*). It is also important to note whether the main veins are dark, or outlined in a pale colour on a darker background; in the latter case, the wing has the appearance called *reticulated*. In the hindwing, there is always a bicolorous pattern, the wing being divided into a *basal area*, nearly always bright red, but some-

times purple, and a *marginal area*, usually grey-black, but sometimes purple. If the division between these two areas is a definite clear-cut line, it is said to be *eulegnic*; if it is irregular and diffuse, then it is called *dyslegnic*; these terms being those originally proposed by Professor Poulton for similar conditions in the wings of butterflies.



Text-fig. 2.—Diagram of the markings on the forewing in the genus *Eusthenia*. *hm*, humeral veinlet; *ln*, lunule; *rs*, radial stripe; *sm*, subhumeral oval mark.

Text-fig. 3.—*Eusthenia lacustris*, n.sp., ♂. Anal appendages of male, lateral view (x 20). *c*, cercus; *p*, penis; *sa*, superior appendage.

The males of the subfamily *Eustheniinae* have a peculiar specialisation not found in the *Stenopterlinae*, in that the penis is greatly elongated and curved up over the tenth tergite. This condition is shown in Text-fig. 3. In pairing, the male clings to the back of the female, but brings the tip of his abdomen round under hers, so that this upcurved and dorsally coiled penis can be used to advantage. The penis is grooved, and the sperm masses are worked by it into a true spermatophore, which is held in the end-loop of the penis. How fertilisation is actually effected I have not been able to see, but it would appear to be done by simple transference of the spermatophore into the vagina of the female. In this connection, it is interesting to note also the lack of specialisation of the vulva of the female. In most Stoneflies this is a definitely projecting and often strongly bifid process; but in the *Eustheniinae* the distal border of the ninth sternite forms only a very slight undivided process. By strong muscular action, the female is able to compress her end segments laterally, giving a wide gape between the ninth and tenth sternites; and this evidently facilitates the process of fertilisation.

The form of the superior appendages of the male (Text-fig. 3, *sa*), and also of the basal joints of the cerei (*c*), are valuable specific characters in the *Eustheniinae*. Unfortunately, females are more commonly met with than males, and my series of the latter is so incomplete that I am unable to use these characters in the Key to the species. I have, however, given a description of them under each separate species, where the males are known to me.

Key to the Genera.

- Wings short and very broadly round at apices, the amplitude of the hindwings very great. Forewing with a very strong reticulation of pale main veins and cross-veins on a darker ground; the costal series of veinlets abundant, without any break after the humeral veinlet *EUSTHENIOPSIS*, n.g.
(Genotype, *E. venosa*, n.sp.)
- Wings longer, less broadly rounded at apices, the hindwings more subtriangular in shape. Forewing with the pale reticulation either less strongly developed or entirely absent; the costal series of veinlets much fewer in number and more widely spaced, especially after the humeral veinlet, where there is usually a more or less lengthy gap *EUSTHENIA* Westwood
(Genotype, *E. spectabilis* Westwood.)

Genus *EUSTHENIA* Westwood. (Plates xi.—xiii., Figs. 2—6.).

Characters as given in the generic key above, to which may be added the following:—Antennae somewhat shorter than the forewings, the basal joint enlarged. Costal space of forewing slightly widened basally, the costal veinlets widely spaced basally, but closer together distally; usually there is a considerable gap between the humeral veinlet and the next costal veinlet, which is frequently placed nearly up to the level of the origin of Rs. In the hindwing, the costal space is not noticeably widened, and there is always a long gap between the humeral veinlet and the next costal veinlet. In the forewing, M diverges from R at about one-third from base, Rs from R at about half-way; Rs has three or four branches. M₅ is well developed in both fore and hind wings, and forms a well marked cubito-median Y-vein with Cu₁, the two arms of the Y being generally about equal in length. Cu₁ in forewing has either two or three distal branches arching up anteriorly from the line of the main vein itself; Cu₂ lies entirely in the anal furrow. Forewing with three anal veins, usually unbranched. In the hindwing, Rs is fused with M basally for a very short distance in the region of the origin of M₅; Rs has either two or three branches; Cu₁ is simple. 1A is weakly formed, and lies very close to Cu₂, with which it is almost fused at about the middle of its length. 2A forks near its origin, and again at or before half-way. 3A sends five or more straight branches into the anal fan, which occupies more than half the total breadth of the wing. Cerei long, many-jointed, varying from somewhat longer to somewhat shorter than the length of the abdomen.

Genotype, *Eusthenia spectabilis* Westwood.

Key to the Species.

1. Wings rich purple, except only the large whitish lunule on the forewing and the red basal third of the hindwing. *E. costalis* Bks.
Wings mostly dark greyish or blackish; purple only along costa of forewing; basal portion of hindwing red 2
2. Lunule of forewing broad, from 2.5 mm. to 4 mm. wide, its basal border not usually as distinctly formed as its distal 3
Lunule of forewing narrow, from 1 mm. to 1.5 mm. wide, with both basal and distal borders clearly defined 4

3. A red radial mark of full length in forewing; the same wing with pale reticulation more or less clearly outlined on all the main veins and cross-veins.
E. spectabilis Westwood
 No red radial mark in forewing, and no pale reticulation except on the cross-veins beyond the lunule *E. purpurescens*, n.sp.
4. Forewing with pale reticulation of main veins and cross-veins; a definite, whitish subhumeral oval mark present on forewing *E. lunulata*, n.sp.
 Forewing without any pale reticulation, the main veins and cross-veins entirely dark; no subhumeral oval mark present *E. lacustris*, n.sp.

EUSTHENIA SPECTABILIS Westwood.

Westwood, in Griffith's "Animal Kingdom," Insects, vol. ii., 1832, p. 348, Pl. lxxii., fig. 4.

Newman, "On the synonymy of the Perlites . . ." Mag. Nat. Hist., New Series, vol. iii., 1839, p. 33.

From Newman's short description we learn that this species had on the forewing, "an elongated red spot near the costal margin" and "beyond and below this a large blotch of dirty white." while the hindwings were "red at the base and black externally." These details would scarcely be enough, by themselves, to determine which of the Tasmanian species was really *E. spectabilis*. But, taken in conjunction with a study of the British Museum series of specimens, they enable us to define the species more accurately.

In the British Museum there are four specimens arranged together under the name "*spectabilis*." The first three of these are conspecific, the fourth is quite distinct. The first specimen bears a label "*E. spectabilis*" and appears to be the type. This and the two following specimens agree with Newman's definition, the red radial stripe being clearly present, and the lunule broad and distinct; in the hindwing, the division between red and grey-black is somewhat dyslegnic, and ends on the costa about half-way. The fourth specimen has no radial stripe, the costal space of the forewing being purpurecent throughout; it differs further from the other three specimens in having the subhumeral oval mark present, in the very dyslegnic division between red and black on the hindwing, with the red tending to spread out distally along the costa, and also in having an exceedingly wide lunule on the forewing.

True *E. spectabilis* may now be defined as follows:—Pronotum with a brownish anterior lobe, distinctly convex, with very distinct sculpture of an arabesque type, slightly raised above the ground level. No subhumeral oval mark on forewing. Radial mark of forewing typically reaching from beneath humeral veinlet to above top of lunule, with a slight downward prolongation on M₅. Lunule fairly well defined, about 2.5 mm. wide, and not completely crossing the forewing. Division between red and black on hindwing somewhat dyslegnic, ending on costa about half-way. The pale reticulation is present on main veins and cross-veins of forewing, being only moderately well outlined in pale grey.

N. Banks states that, in the male of *E. spectabilis*, "the superior appendages are widened at the tip and acute on the inner side." The specimen named *E. spectabilis* by Banks in the Hope Museum, Oxford, is, however, not that species, but is conspecific with the fourth specimen in the British Museum series (= *E. purpurescens*, n.sp. of this paper). As I have no males of *E. spectabilis*, but possess one of *E. purpurescens*, in which the male appendages do not fit this description, it is to be assumed that Banks' remarks do actually apply to the male of *E. spectabilis*.

Type, in British Museum Collection.

Hab.—Tasmania, chiefly in the south (Hobart).

EUSTHENIA SPECTABILIS EULEGNICA, n. subsp. (Plate xiii., Fig. 4.).

I have in my collection a very fine female from Tyenna, Tas., which is clearly closely related to typical *E. spectabilis*, but differs in two important points. The radial mark of the forewings is exceptionally well developed, and sends downwards a strong prolongation covering M_5 ; also the amount of red on the hindwing is greater, and the division between red and black is eulegnic. *Expanse*, 51 mm., *cerci* 12 mm. long. The locality from which this comes is within the new Tasmanian National Park, at over 1000 feet elevation. It appears well worthy of subspecific rank.

Type: Holotype ♀, in Tillyard Collection, Cawthron Institute, Nelson, N.Z. Taken by C. E. Cole, 29.12.1916, at Tyenna, Tasmania.

EUSTHENIA PURPURESCENS, n.sp. (Plate xiii., Fig. 6.).

♀, *expanse* 52 mm. Allied to *E. spectabilis*, from which it may be at once distinguished by the following characters:—Pronotum with the front and hind borders brown, the former straight in the middle, not so regularly convex as in *E. spectabilis*. Cerci with the basal joints shorter and less strongly ciliated. Forewings without any radial mark; the costal space is purpuresecent, with the radius darkly shaded in grey-black; the subhumeral oval mark is present, whitish touched with purple, and followed distally by a blackish patch attached below R and then descending obliquely along Cu; the lunule has a rather irregular basal outline, and is widest anteriorly where it ends just beneath R. There is no reticulation of the main veins in pale outline, but the cross-veins beyond the lunule are so marked. In the hindwing, the division between red and purplish black is somewhat dyslegnic, and is very distinctly angulated on the vena dividens (Cu_2).

♂, *expanse* 41 mm.; *cerci* 16 mm. long, black, downy, with short, weak cilia, basal joints stout, not as long as wide; *superior appendages* short, tips somewhat blunt. Colouration as in ♀.

Types: Holotype ♀, and allotype ♂ in Tillyard Collection, Cawthron Institute, Nelson, N.Z. Taken by G. H. Hardy, 6.12.1913, at Hobart, Tasmania.

Hab.—Tasmania, chiefly in the south.

EUSTHENIA PURPURESCENS EXTENSA, n.subsp.

A fine female taken by Mr. C. E. Cole at Russell, Tasmania, on Dec. 26th, 1916, differs from the type in having the red colour of the hindwing spreading distally far along the costa, the subhumeral oval mark of the forewing not so clearly indicated, the pale reticulation present, but weakly formed, on all parts of the forewing, and the lunule not quite so wide anteriorly. This form appears to be a good subspecies.

Type: Holotype ♀, in Tillyard Collection, Cawthron Institute, Nelson, N.Z.

As Russell is not far from Tyenna, it appears that, in the elevated National Park area, each species known from the Hobart district is there represented by a distinct subspecies.

EUSTHENIA LUNULATA, n.sp. (Plate xii., Fig. 3.)

♀, *expanse* 48 mm. Allied to *E. spectabilis*, with which it agrees in general colouration and appearance, but differs in the following important points:—Pronotum dark olive, the anterior border not marked with brown, the arabesque sculpture intricate, dissimilar from that of *E. spectabilis*. Forewings with the pale reticulation moderately well marked everywhere except along the costal

space; a considerable gap between the humeral veinlet and the next costal veinlet, which arises just before the origin of Rs. Subhumeral oval mark small but well defined. Radial red mark very small, beginning beyond the point of departure of M from R+M, and ending just before the level of the lunule. Lunule very distinct, whitish, very narrow (barely 1.5 mm. wide), forming a very distinct crescent, not touching R. In the hindwings, the division between red and grey-black is eutegnic, beginning about half-way along the costa, then proceeding downwards at right angles to the costa as far as the vena dividens, where it bends sharply round, leaving an amount of marginal black on the anal fan almost as wide as the greatest width of the red.

♂, expanse 36 mm. *Cerci* 10 mm. long, black with rings of pale brown cilia, basal joints longer than wide. *Superior appendages* bluntly rounded at apices, with a strong, short spine at outer distal angle. Closely resembling the female, but differing in its much smaller size, and in having the distal border of the lunule not quite so regular, and the lunule itself slightly wider in comparison with its length.

Types: Holotype ♀ and allotype ♂ in Tillyard Collection, Cawthron Institute, Nelson. Both taken at Cradle Mountain, Tasmania, altitude about 3000 feet, the female on January 21st, the male on Jan. 23rd, 1917. Also a paratype ♀ from same locality, Jan. 23rd, 1917.

Hab.—Only known from the streams around Cradle Mountain at high elevations.

EUSTHENIA LACUSTRIS, n.sp. (Plate xii., Fig. 5.)

♀, expanse 47 mm. A very distinct species, easily recognised by the following characters:—The whole body shining black; femora black, the tibiae and tarsi brownish. Forewings brownish black with black veins showing up clearly; pale reticulation entirely absent; costal space purple, the same colour extending beyond the lunule right to the apex; base of wing for about 2 mm. is also purplish, and this colour just reaches the very indistinct subhumeral oval mark. Lunule whitish, very clearly defined, narrow (about 1.5 mm. wide), not quite reaching the posterior margin of the wing, and confluent above with the radial mark; this latter is very strongly developed, bright red, and confluent with the whole width of the lunule distally; it also sends a strong transverse prolongation downwards covering the whole of M₅. Hindwings with the division between red and black moderately eutegnic, shaped as in *E. lunulata*, but with the red occupying a larger area of the base of the wing.

♂, expanse 39 mm. *Cerci* 12 mm., black, strongly ciliated, basal joints about as wide as long. *Superior appendages* blunt at tips, and each carrying on its basal half inwards a strongly projecting spine. Closely resembling the female, but with the red of the radial mark extending anteriorly on to the costa. A lateral view of the appendages is shown in Text-fig. 3.

Types: Holotype ♀ and allotype ♂, in Tillyard Collection, Cawthron Institute, Nelson, N.Z. (taken *in cop*, Lake Lilla, Cradle Mountain, Tasmania, Jan. 12th, 1917); also a series of paratypes of both sexes, taken around Cradle Mountain in the same month.

Hab.—Lakes Lilla and Dove, and Crater Lake, Cradle Mountain, about 3200 feet, Tasmania. This is the only species known to me whose larva inhabits the still water of lakes. All the others live in the fast running mountain torrents.

This species is probably most closely allied to *E. lunulata*, with which it agrees in the narrow form of the lunule, but can be at once separated from it by

the absence of pale reticulation on the forewing, the strong development of the radial mark, and the greater amount of red on the hindwing.

EUSTHENIA COSTALIS N. Banks. (Plate xi., Fig. 2.)

Banks, "Synopsis and Descriptions of Exotic Neuroptera." Trans. Amer. Ent. Soc., xxxix., 1913, p. 204.

There is a single male of this very beautiful species in my collection, taken at Cradle Mountain. This has been compared with Banks' type. The short description given by Banks may now be supplemented as follows:—

♂. expanse 43 mm. Cerci 14 mm. long, dark brown, strongly ciliated, with basal joints very short, much wider than long. Superior appendages very short, acutely pointed. Forewings purplish, with pale reticulation weakly developed on the anal area and on the cross-veins beyond the lunule. Subhumeral oval mark very distinct, pale yellowish. No red radial stripe present. Lunule whitish tinged with purple, very clearly defined, about 2.8 mm. wide, nearly reaching the costa, and ending posteriorly on the wing border 2 mm. wide. Hindwings with the basal part orange red, this colour extending to about half way on the costa, but much less in other directions; by far the greater area of the wing is a beautiful purple. The division between red and purple is strongly dyslegnic, the purple encroaching irregularly on the red.

Type: Holotype ♂ in Museum of Comparative Zoology, Cambridge, Mass, U.S.A. (Taken by A. M. Lea at Magnet, Tasmania).

Hab.—High elevations in North Western Tasmania.

Genus EUSTHENIOPSIS, n.g. (Plate xiv., Fig. 7.)

Characters as given in the Key on p. 228.

Genotype. *E. venosa*, n.sp.

Distribution:—Tasmania and Southern Victoria.

Key to the Species

Basal area of hindwing purple; pronotum normal *E. venosa*, n.sp.
 Basal area of hindwing red; pronotum with raised lateral edges and strongly projecting antero-lateral angles *E. reticulata* Klap. MS.

EUSTHENIOPSIS VENOSA, n.sp. (Plate xiv., Fig. 7.)

♀. expanse 40 mm. Pronotum dark grey, bordered in front and behind with brown. Fore femora with a pale yellowish ring apically. Forewings dark brown, with very strong and distinct pale reticulation of all the main veins and cross-veins; a small amount of similar reticulation is also to be seen near the apex of the hindwing. In the forewing, the costal veinlets number about twenty. Subhumeral mark present, whitish; another small squarish blotch of the same colour covers M₅. No red radial stripe present. Lunule exceedingly narrow (little over 1 mm. wide in middle), and with both borders irregular; it reaches from Sc to the posterior margin of the wing. Hindwings with the basal three-fifths purple, the area occupied by this colour being squarish, strongly angulated on the vena dividens, and with its border somewhat concave above this angle. Rest of hindwing dull greyish-black, the division between purple and black eulegnic.

Type: Holotype ♀ in the collection of the National Museum, Melbourne, Victoria (labelled "Narracan, 1.94"). A second specimen from the same locality is in the Cawthron Institute Collection, Nelson, N.Z.

Hab.—Victoria.

EUSTHENIOPSIS RETICULATA Klap. MS.

In the British Museum Collection there is a single specimen carrying a label "*Eusthenia reticulata* Klap." I can find no record of any published description of this insect by Klapalek, and I assume that he must have studied the insect and attached the MS name to it, but that his description has never been published. I propose, therefore, to retain the name *reticulata* given by him, and to indicate the special characteristics of the species.

Pronotum with strong lateral ridges and strongly marked antero-lateral angles. Forewing with all the main veins and cross-veins strongly outlined as a pale reticulation. Subhumeral oval mark completely swallowed up in a large whitish basal patch, which is followed distally by a dark subrectangular patch. There is no red radial stripe on the forewing. Lunule rather narrow, very distinct, stretching right across the forewing. Hindwing red basally, blackish distally, the division between the two colours being eulegmic, and beginning well beyond half-way along the costa.

In general shape and appearance, this insect strongly resembles *E. venosa*, particularly in the short, strongly rounded wings, and in the very strongly marked pale reticulation. It differs, however, in the remarkable form of the pronotum, and in having the basal area of the hindwing red instead of purple.

Type: Holotype ♀ in British Museum Collection.

Hab.—Tasmania.

Subfamily STENOPERLINAE, n.subfam.

Characters as given in the Key on p. 224.

Key to the Genera.

Very large insects, expanding 80 mm. or over; antennae nearly as long as forewing; pronotum half as wide again as long; costal series of veinlets complete and abundant in fore and hind wings; cross-veins between M and Cu₁ in forewing all connected by short cross-bars, so as to form two rows of cellules.

DIAMPHIPNOA Gerst.

Genotype, *D. annulata* (Br.)

Moderately large insects, expanding from 50 to 70 mm.; antennae from one-half to two-thirds as long as forewing; pronotum somewhat heart-shaped, about as wide as long; costal series of veinlets few and incomplete, there being always a long gap between the humeral veinlet and the next one; cross-veins between M and Cu₁ in forewing normal, forming only a single row of cellules, only occasionally connected by a cross-bar STENOPERLA McLach.

Genotype, *S. prasina* (Newm.).

Genus STENOPERLA McLach. (Plate xv., Figs. 9, 10.)

Characters as given in the generic key above.

Genotype, *Stenoperla prasina* (Newman).

Key to the Species.

Forewings bright green, hindwings pale, tinged with green. New Zealand.

S. prasina (Newm.)

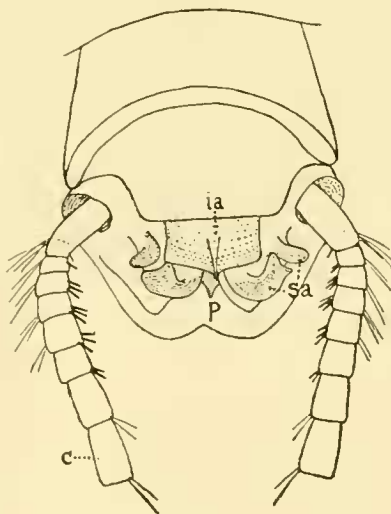
Forewings mottled grey, hindwings tinged with orange pink basally and on anal fan, mottled grey distally. Australia *S. australis*, n.sp.

STENOPERLA PRASINA (Newman). (Plate xv., Fig. 9.)

Newman, Zoologist, vol. iii., 1845, p. 852 (under *Chloroperla*).

This well known insect is quite common in many parts of New Zealand though in places its numbers have been greatly diminished by the introduced trout, of which the larva forms a favourite food.

There is considerable variation in details of the venation, such as the number of costal veinlets, the number of branches of R_s and Cu_1 in forewing, and the condition of the space between R_s and M in both wings; this latter space is usually free from cross-veins in its basal half, but occasionally has one or more present there. The tracheation of the larval wing of this species is shown in Text-fig. 1. The cerci and anal appendages of the male are shown in Text-fig. 4. It should be noted that the short basal joints of the cerci, in this sex, carry, on the inner side, sets of from one to three short strong bristles, and, on the outer side, longer and slenderer hairs. The superior appendages and penis are up-



Text-fig. 4.—*Stenoperla prasina* (Newman), ♂. Anal appendages of male, ventral view (x 20). *c*, cercus; *ia*, inferior appendage; *p*, penis; *sa*, superior appendage.

curved, but much shorter than in the *Eustheniinae*; the former are broad and slightly widened at the apex, and carry basally on the inner side a very distinct process with a rounded tip; the penis is somewhat shorter than the appendages, its apex more pointed.

An interesting variety of this species occurs occasionally, in which the green colour is entirely replaced by yellow. The forewings, in the specimens which I have seen, are generally somewhat shorter than in typical specimens, but I can find no other morphological differences.

Type in British Museum Collection.

Hab.—The whole of New Zealand, in the neighbourhood of fast running streams.

STENOPERLA AUSTRALIS, n.sp. (Plate xv₉, Fig. 10.)

♂. *erpanse* 54 mm. Head dark grey, marked with brown on epieranium; eyes black; antennae 11 mm. long, dark brown, basal joint much enlarged, second joint very short, slightly wider than third, which is rather long and cylindrical; mouth-parts and underside of head bright orange brown, palps dull grey-brown.

Thorax: *Pronotum* dark grey, brown along anterior border. *Meso-* and *metathorax* shiny brownish. *Legs* dark grey touched with brown.

Abdomen (shrivelled) dark brown. *Cerci* 5 mm. long, black with pale brown eilia. the basal joints somewhat shorter than wide. *Superior appendages* upcurved, dark brown, the outer border convex, the tips hard, black, inclined inwards. *Penis* a little longer than appendages.

Type: Holotype ♂, taken by Dr. A. J. Turner at Montville, Blackall Ranges, Queensland, Oct. 5th, 1912; in Tillyard Collection, Cawthron Institute, Nelson, N.Z. In the same collection there are also a male bred from a larva taken at Maleny, near Montville, by myself, on Nov. 28th, 1915, and a larger specimen, expanse 60 mm., probably a female, but with abdomen missing, taken by Mr. G. Lyell at Stanwell Park, N.S.W., on April 22nd, 1916. Another specimen labelled "Victoria, Whittlesea" is in the Collection of the National Museum, Melbourne.

Hab.—Fast mountain streams in Eastern Australia, but not Tasmania. The larvae exuviae are common objects on the rocks in the streams of the Blue Mountains, N.S.W., but the perfect insect is seldom seen, as it flies but little.

Genus *DIAMPHIPNOA* Gerst. (Plate xiv., Fig. 8.)

Characters as given in the generic key on p. 233. The imago has four pairs of abdominal gills, on segments 1—4, carried over from the larva. I think this carrying over of abdominal gills in the imago occurs in all the *Eustheniidae*, as I have certainly seen them in newly-emerged specimens of *Eusthenia lacustris* and *Stenoperla australis*; but they very soon shrivel up, so as not to be clearly discoverable in mature specimens. Probably the great size of the species *D. annulata* makes it possible, in this case, to see these delicate organs more clearly in the imago.

Genotype, *Diamphipnoa annulata* (Brauer).

DIAMPHIPNOA ANNULATA (Brauer). (Plate xiv., Fig. 8.)

Stenoperla annulata, Brauer, Verhandl. zool.-bot. Gesell. Wien, xix., 1869, p. 17. Chili.—*Diamphipnoa lichenalis*, Gerst., Festschr. nat. Freunde, 1873, p. 64, fig. 17.

There is a magnificent specimen of this fine insect in the Hope Museum at Oxford. *Forewing*, 44 mm.; *antenna*, 35 mm.; *total length*, 28 mm.; *expanse*, 90 mm.; *cerci*, 8 mm. The general colour is grey, the forewings grey with dark brown veining and irregular clouding of brown along the cross-veins, especially at each end where they join with the main veins; the hindwings paler grey, with brown veins, and clouding of darker grey at ends of the veinlets along distal half of costal border. The specimen is a female, labelled "Chili, 1860." The photograph shown in Plate xiv., fig. 8, is taken from this insect.

Cawthron Institute, Nelson, N.Z., 12.3.1921.

EXPLANATION OF PLATES XI.—XV.

Plate xi.

Fig. 1. *Thaumatoperla robusta*, n.g. et sp., ♀. (x 2.7).

Fig. 2. *Eusthenia costalis* N. Banks, ♂. (x 2.7).

Plate xii.

- Fig. 3. *Eusthenia lunulata*, n.sp., ♀. (x 2.7).
Fig. 5. *Eusthenia lacustris*, n.sp., ♀. (x 2.5).

Plate xiii.

- Fig. 4. *Eusthenia spectabilis eulegnica*, n.subsp., ♀. (x 2.7).
Fig. 6. *Eusthenia purpurescens*, n.sp., ♂. (x 2.4).

Plate xiv.

- Fig. 7. *Eustheniopsis venosa*, n.g. et sp., ♀. (x 2.7).
Fig. 8. *Diamphipnoa annulata* (Brauer), ♀. (Hope Museum, Oxford). (x 1.4).

Plate xv.

- Fig. 9. *Stenoperla prasina* (Newman), ♀. (x 2.4).
Fig. 10. *Stenoperla australis*, n.sp., ♂. (x 2.3).

Photographs for Figures 1, 2, 5 and 7 were taken by Mr. J. Tutcher of Bristol England; for Figures 3, 4, 6, 9 and 10 by Mr. W. C. Davies, Curator of the Cawthron Institute, Nelson; Figure 8 was sent to me by Professor E. B. Poulton, F.R.S., Hope Professor of Zoology, Oxford University, and was enlarged by Mr. Davies. I desire to thank all these gentlemen for the excellent series of photographs provided by them for this paper.